

WHAT IS CLAIMED

1. An optical modulator comprising:
  - a first phase modulator operable to phase modulate an optical carrier signal according to a first data stream to generate a modulated optical signal; and
  - 5 a second phase modulator operable to phase modulate the modulated optical signal according to a second data stream to generate an optical data signal, wherein the second data stream comprises a time-delayed version of the optical data signal.
- 10 2. The optical modulator of Claim 1, wherein the second data stream comprises a version of the optical data signal having a one bit-period delay.
- 15 3. The optical modulator of Claim 1, further comprising:
  - a converter operable to convert the optical data signal into an intensity modulated optical data signal; and
  - 15 a photodetector operable to convert the intensity modulated optical data signal into an electrical data stream, the electrical data stream delivered to the second phase modulator as the time-delayed version of the optical data signal.
- 20 4. The optical modulator of Claim 1, further comprising:
  - a first optical splitter coupled to the first phase modulator and operable to split a received optical carrier signal into the optical carrier signal for the first phase modulator and a second optical carrier stream;
  - 25 a second optical splitter coupled to the second phase modulator and operable to split the optical data signal from the second phase modulator into a first optical data stream and a second optical data stream;
  - an optical coupler coupled to receive input from the first splitter and the second splitter, the optical coupler operable to interfere the second optical data stream and the second optical carrier stream to generate an intensity modulated optical data signal; and
- 30 a photodetector operable to convert the intensity modulated optical data signal into an electrical data stream, the electrical data stream delivered to the second phase modulator as the time-delayed version of the optical data signal.

5. The optical modulator of Claim 4, wherein a splitting ratio of the first splitter and a splitting ratio of the second splitter are configured such that a power of the second optical carrier stream and a power of the second optical data stream are  
5 substantially equal.

6. The optical modulator of Claim 1, further comprising a tunable delay module operable to selectively control delay of the time-delayed version of the optical data signal.

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7. The optical modulator of Claim 1, wherein an electrical feedback line delivering the second data stream to the second phase modulator is configured to provide an electrical version of the optical data signal having a one bit-period delay.

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8. The optical modulator of Claim 1, wherein the first data stream and the second data stream each comprise electrical data signals.

9. A method for precoding optical data signals comprising:  
receiving an optical carrier signal;  
receiving a first electrical data stream;  
phase modulating the optical carrier signal according to the electrical data  
5 stream to generate a modulated optical signal;  
phase modulating the modulated optical signal according to a second electrical  
data stream to generate an optical data signal, wherein the second electrical data  
stream comprises a time-delayed version of the optical data signal.

10 10. The method of Claim 9, wherein the second electrical data stream  
comprises a version of the optical data signal having a one bit-period delay.

11. The method of Claim 9, further comprising  
converting the optical data signal into an intensity modulated optical data  
15 signal; and  
converting the intensity modulated optical data signal into the second  
electrical data stream; and  
delaying the second electrical data stream such that the second electrical data  
stream is delivered to the second phase modulator as the time-delayed version of the  
20 optical data signal.

12. An optical modulator comprising:

a first optical splitter having an optical input, a first optical output, and a second optical output;

5 a first phase modulator having an optical input, an optical output, and an electrical data input, the optical input coupled to the first optical output of the first optical splitter;

a second phase modulator having an optical input, an optical output, and an electrical data input, the optical input coupled to the optical output of the first phase modulator;

10 a second optical splitter having an optical input, a first optical output, and a second optical output, the optical input coupled to the optical output of the second phase modulator;

15 an optical coupler having a first optical input, a second optical input, and an optical output, the first optical input coupled to the optical output of the first optical splitter, and the second optical input coupled to the optical output of the second optical splitter; and

a photodetector having an optical input and an eletrical output, the optical input coupled to the optical output of the optical coupler, and the electrical output coupled to the electrical data input of the second phase modulator.

13. An optical modulator comprising:

  - means for receiving an optical carrier signal;
  - means for receiving a first electrical data stream;
  - means for phase modulating the optical carrier signal according to the electrical data stream to generate a modulated optical signal;
  - means for phase modulating the modulated optical signal according to a second electrical data stream to generate an optical data signal, wherein the second electrical data stream comprises a time-delayed version of the optical data signal.

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14. An optical modulator comprising:

a plurality of electrical precoding modules, each of the precoding modules operable to receive a data stream and to precode the data stream; and

5 a plurality of phase modulators coupled in series, each of the phase modulators operable to receive the precoded data stream from a corresponding one of the precoding modules, to receive an optical signal from a preceding one of the phase modulators in the series, and to modulate the received optical signal according to the precoded data stream from the corresponding precoding module.

10 15. The optical modulator of Claim 14, wherein each of the precoding modules is further operable to precode the data stream by performing an exclusive or operation between the data stream and an output of the precoding module.

15 16. The optical modulator of Claim 14, wherein each of the precoding modules comprises:

a D flip-flop having an input and an output; and  
an exclusive or gate having a first input coupled to receive the data stream, a second input coupled to the output of the D flip-flop, and an output coupled to the input of the D flip-flop, the output of the exclusive or gate further coupled to a  
20 corresponding one of the phase modulators.

17. The optical modulator of Claim 14, further comprising one or more delay modules, each of the delay modules disposed between one of the precoding modules and a corresponding one of the phase modulators.

18. A method for precoding optical data signals comprising:  
receiving a plurality of electrical data streams all having communications at a  
first data rate;  
electrically precoding each of the electrical data streams;  
5 receiving an optical carrier signal;  
phase modulating the optical carrier signal according to each of the electrically  
precoded data streams to generate an optical data signal encoding information from all  
of the electrical data streams, the optical data signal having communications at a  
second data rate equal to the number of electrical data streams multiplied by the first  
10 data rate.

19. An optical modulator comprising:
  - means for receiving a plurality of electrical data streams all having communications at a first data rate;
  - means for electrically precoding each of the electrical data streams;
  - 5 means for receiving an optical carrier signal;
  - means for phase modulating the optical carrier signal according to each of the electrically precoded data streams to generate an optical data signal encoding information from all of the electrical data streams, the optical data signal having communications at a second data rate equal to the number of electrical data streams multiplied by the first data rate.

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20. An optical modulator comprising:

a first precoding module having an input and an output, wherein the input receives a first electrical data stream, and the output transmits a first precoded electrical data stream;

5 a second precoding module having an input and an output, wherein the input of the second precoding module receives a second electrical data stream, and the output of the second precoding module transmits a second precoded electrical data stream;

10 a first phase modulator having an optical input, an optical output, and a data input coupled to the output of the first precoding module, wherein the optical input receives an optical carrier signal, the first phase modulator modulates the optical carrier signal according to data received on the data input to generate a modulated optical signal, and the optical output transmits the modulated optical signal; and

15 a second phase modulator having an optical input coupled to the optical output of the first phase modulator, an optical output, and a data input coupled to the output of the second precoding module, wherein the second phase modulator modulates the modulated optical signal according to data received on the data input from the second precoding module to generate an optical data signal.